DOCUMENT RESUME

ED 138 546 SP 010 951

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TITLE Affective Evaluation of Science Teacher Education Project.
PUB DATE 77
NOTE 16p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Changing Attitudes; *Inservice Teacher Education; Science Curriculum; Science Education; *Science Teachers; Secondary School Teachers; *Summer Institutes; *Summer Workshops; *Teacher Attitudes; Teacher Education
IDENTIFIERS *Intermediate Science Curriculum Study

ABSTRACT

A semantic differential instrument containing a series of 25 concepts was administered to 29 junior high school science teachers at the beginning and conclusion of a six-week summer institute organized to prepare teachers to teach the new Intermediate Science Curriculum Study (ISCS) program. Teachers were provided with the opportunity for in-depth study of the philosophy, rationale, and content of the ISCS materials. The measurement instrument was designed to measure the teachers' attitudes toward certain aspects of the ISCS. Pre- and post-test scores for each concept presented on the instrument were analyzed; for nine of the concepts there was a significant change. At the conclusion of the institute, the teachers were more favorably disposed toward discovery, independent study, inquiry, model building, laboratory investigations, problem solving, science as content, science as a way of thinking, and science as process. The significant changes observed with regard to the nine concepts contained in the semantic differential instrument support the hypothesis that teacher attitudes can be changed through institute experience. (MM)

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ED138546

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AFFECTIVE EVALUATION OF SCIENCE TEACHER EDUCATION PROJECT

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ABSTRACT

A semantic differential instrument containing a series of twenty-five concepts was administered to twenty-nine junior high school science teachers at the beginning and conclusion of a six-week Summer Institute at the University of Virginia. The instrument was designed to measure teachers' attitudes toward certain aspects of the "new" science curricula. Pre- and posttest scores for each concept presented in the instrument were analyzed using the correlated t-test. For nine of the concepts there was a significant change in the mean score. At the conclusion of the Institute, the teachers were more favorably disposed toward discovery, independent study, inquiry, model building, laboratory investigations, problem solving, science as content, science as a way of thinking, and science as process.

SP010 951

FOR SEVERAL YEARS, the National Science Foundation and other organizations have spent considerable money in an effort to upgrade science teachers through academic year institutes, summer institutes, in-service institutes, and special projects. These programs have had a tremendous impact upon science education. Nevertheless, there is need for evaluating the work which is being done in this area. The programs need to be examined for their general effectiveness. They also need to be examined in an effort to determine what types of procedures are most effective in reaching the stated goals or objectives of specific programs within institutions and the national organizations which support the projects.

This report deals with an evaluation of one of the goals of a National Science Foundation supported Summer Institute at the University of Virginia. The main objective of the institute was to introduce junior high school teachers to, and prepare them to teach, the Intermediate Science Curriculum Study (ISCS) program in grades seven, eight, and nine. (4) This was to be accomplished by providing the teachers with an opportunity for in-depth study of the philosophy, rationale, and content of the ISCS materials. The teachers performed the student experiments for most of the basic core activities and some selected excursions for Levels I, II, and III. They also worked through and discussed the available teacher training modules which have been prepared by the ISCS staff at Florida State University.

Another objective of the institute was to enrich the content background of the junior high school teachers relative to the science concepts which are presented in ISCS. This was to be accomplished by discussions which evolved out of problems or difficulties which the teachers experienced while doing the laboratory activities.

A third major objective of the institute was to give each of the participants a better understanding of the role the teacher has to assume to make such a program successful. The teacher's role is more that of adviser than instructor. Greater emphasis is placed on the need for planning on the part of the teacher in terms of acquisition, storage, maintenance, dispensing, use, and collecting of equipment and supplies. The teacher must be continuously available to act as a resource person and provide help and guidance to the individual student in interpreting his observations. The teacher's acceptance of this role as reflected by the attitudes of the participants was the primary area of investigation in this study.

For the purposes of this study, the investigators made the assumptions that the success of a teacher is a function of that teacher's disposition toward the instructional materials and his attitude toward the approach to teaching inherent in that program. If these assumptions are valid, then it seems imperative that the formation of positive attitudes toward the science program in question and the inquiry-inductive approach to teaching are desirable and necessary goals for this type of teacher education program.

Several activities which were a part of the Institute program were designed to foster the formation of positive attitudes. Experimental editions of teacher training modules produced by ISCS were used to help develop the rationale, classroom organization, and student evaluation aspects of ISCS. Participants also worked through the student instructional materials. All of these ISCS instructional materials for teachers and students are self-pacing and individualized in nature. In addition, the participants were grouped together in university housing and participated in the same classroom activities throughout the six-week Institute, six to eight hours a day.

RELATED LITERATURE

Much of the literature related to the evaluation of institutes deals with the description of teachers who participated in the program or reports teachers' feelings about past institute experiences through the use of follow-up questionnaires. Koelsche (1) reported on persons submitting applications for participation in NSF institute programs at the University of Georgia while Slawson (6) surveyed the reactions of former participants to their institute experiences. Slawson also questioned the former participants about the ways in which the institute experience had assisted them in obtaining their present positions or helped them function in the positions which they occupied.

Welch and Walberg (8), after sighting the need for objective evaluation of institutes, evaluated four summer institutes using the Test on Selected Topics in Physics (9), Test on

Understanding Science (5), and Science Process Inventory (7) as measurements of attainment of cognitive objectives. Welch and Walberg reported that participants from the four institutes made significant gains on the Test on Selected Topics in Physics. At three institutes participants made significant gains on the Test on Understanding Science and at two institutes participants made significant gains on the Science Process Inventory.

Rothman (3) compared the responses of thirty-six physics teachers who had participated in a summer institute to those of a control group. There was no overall difference between the groups in the area of "student activities" based on a semantic differential type instrument. There was a significant difference at the 0.01 alpha level in the scores of the two groups on "content" scores. According to Rothman, the experimental teachers rated science more understandable and physics in their lives less complex after an institute experience.

Wonkka (10) conducted an extensive evaluation of change of attitudes of participants in in-service institutes at the University of Virginia. Eleven in-service institutes were tested at the beginning and end of the year with an author-constructed instrument in an effort to measure changes in attitudes related to the "new" science curricula. The instrument was an Osgood type semantic differential test (2) with investigator selected concepts and polar adjective pairs. Wonkka concluded that the in-service courses did not significantly affect the development of favorable

or unfavorable attitudes with respect to the concepts associated with the new science programs. However, the mean gain for all teachers was in the positive direction.

The literature reviewed suggests that little effort has been made to evaluate the development of attitudes through science institutes. While most authors report gains in various cognitive areas, less evidence is given to support equal gains in affective objectives.

METHODOLOGY

Problem

In evaluating the attitudinal development of the Institute participants, the following questions were generated:

1. Did the Summer Institute program at the University of Virginia bring about a positive change in teacher attitudes toward the self-pacing lab-oriented approach to teaching science represented by ISCS?

2. In addition, can one use the biographical data obtained from the Institute application form to identify which teachers had the most potential for positive changes in the aforementioned attitudes?

In answering these questions, the investigators tested the following hypotheses:

1. There are no differences between means of the pre- and posttest concept scores on the semantic differential instrument.

2. There is no difference between means of the pre- and posttest scores on the total semantic differential instrument.

3. There are no relationships between the biographical data of the participants and change in attitude as measured by the semantic differential instrument.

The .05 level of significance was selected as appropriate for the testing of all three hypotheses.

Procedures

During the first week of the Summer Institute, a semantic differential instrument developed by Wonkka (10) was administered to all of the participants in a single forty-five minute session. Participants were allowed to take as much time as they needed to complete their responses. The same instrument was administered during the last (sixth) week of the Institute. The twenty-five concepts presented in the instrument are listed in Table 1. The polarity listed for each concept was assigned and supported through research findings by Wonkka (10).

(INSERT TABLE 1 HERE)

Each concept (word or phrase) was listed as a separate page of the instrument. A series of fifteen descriptive scales was printed below each concept in the format shown below.

(Concept) Discovery

(Scale) Valuable___: ___: ___: ___: ___: ___: ___: Worthless

Previous research by Wonkka had found the value of the subtle-obvious scale to be questionable; therefore, this pair of polar adjectives was eliminated from consideration in the results. The fifteen adjective pairs used in this study are listed in Table 2.

(INSERT TABLE 2 HERE)

A key to the scales of adjective pairs was listed at the top of each page of the instrument to facilitate the participants'

marking of the scales. This key is shown below.

Key to the scales of adjective pairs, X and Y:

(1) very closely related to X	(7) very closely related to Y
(2) quite closely related to X	(6) quite closely related to Y
(3) only slightly related to X	(5) only slightly related to Y

(4) neutral, equally X or Y, neither X nor Y

X___:___:___:___:___:___:___Y
(1) (2) (3) (4) (5) (6) (7)

Detailed written instructions for use of the instrument were printed on the cover and a verbal explanation of the procedure to be followed was given.

The response sheets for both the pre- and posttests were hand scored. The scores for each concept were determined by summing across the fifteen adjective pairs after the method of Osgood. (2) The data was transferred to computer cards and a computer program was written to obtain mean pre- and posttest concept scores and correlated t-values, $t = \overline{D} / [\Sigma d^2 / N(N-1)]^{1/2}$. The gain scores from pre- to posttest for the total instrument was used as the dependent variable in an effort to obtain an indication of what kinds of teachers have the greatest potential for changing attitudes. The multiple linear regression technique was used in an effort to predict the teacher's gain scores on the basis of selected available biographical data. In this analysis, the independent variables consisted of the following teacher characteristics: age; teaching experience; total amount of course work in science; amount of course work in each of the four major science areas, mathematics, and education; sex; advanced degree status; prior institute experience; and college major.

PRESENTATION AND ANALYSIS OF DATA

For nine of the twenty-five concepts contained in the instrument, there was a significant difference in the participants' mean pre- and posttest scores. The mean total instrument scores also were significantly different for the pre- and posttest data. The mean scores and total instrument scores are listed in Table 3.

(INSERT TABLE 3 HERE)

The mean for eight of the nine concepts listed in Table 3 changed in a positive direction. The teachers reacted more favorably to these concepts at the conclusion of the Institute. The change in the mean for the "science as content" was negative. The teachers also gave a higher rating to this concept, but the instrument author had designated this as a "negative concept" on his polarity scale (See Table 1). Therefore, in light of the instrument author's assigned desirability characteristics for the concepts, this was not a favorable change.

The t-values and levels of significance for the concepts and total instrument scores for the pre- and posttests also are listed in Table 3.

The multiple linear regression analysis revealed only one significant predictor of gain scores at the 0.05 alpha level. Knowledge of the participants' sex aided in the prediction of the gain scores. The mean gain for women (on the total instrument scores) was higher than for men. Although the only significant individual predictor was knowledge of the participant's sex, the multiple correlation value of all the predictors with the dependent variable, total instrument gain score, was 0.73.

CONCLUSIONS

The significant changes observed with regard to nine concepts contained in the semantic differential instrument support the supposition that teacher attitude can be changed through institute experience. The authors were unable to identify meaningful participant biographical variables which are valid predictors of attitude change. The changes in participants' attitudes suggested by the significant changes in concept means seem to be desirable in light of the apparent goals of ISCS. Those concepts for which positive mean gains were observed appear to be concepts for which gains would indicate improved ISCS teacher attitudes.

During the institute, the participants took part in several activities which might have contributed to the observed changes in attitudes. Experimental editions of teacher training modules produced by ISCS were used to ehlp develop the rationale, classroom organization, and student evaluation aspects of ISCS. Participants also worked through the student instructional materials. All of these ISCS instructional materials for teachers and students are self-pacing and individualized in nature. In addition, the participants were grouped together in university housing and participated in the same classroom activities throughout the six-week Institute, six to eight hours a day. While it would be difficult to relate the observed changes in participants' scores on the concept scales to specific experiences in the Institute, it is encouraging to know that this teacher education model can be effective in developing desirable teacher attitudes. Further research is needed to clarify or identify specific factors at work during an institute which might explain changes like those observed in this study.

TABLE 1

INSTRUMENT CONCEPTS AND THEIR ASSIGNED POLARITY

1. Affective Objectives (+)
2. Discussion (+)
3. Science (+)
4. Scientific Literacy (+)
5. Discovery (+)
6. Textbook as Only Resource (-)
7. Facts (-)
8. Concepts (+)
9. Library of Resource Materials (+)
10. Independent Study (+)
11. Demonstrations (-)
12. Inquiry (+)
13. Lecture (-)
14. Model Building (+)
15. Laboratory Investigations (+)
16. Problem Solving (+)
17. Activity (+)
18. Science as Content (-)
19. Multi-media (+)
20. Science as a Way of Thinking (+)
21. Cognitive Objectives (+)
22. Science as a Body of Knowledge (-)
23. Authority (-)
24. Programmed Instruction (+)
25. Science as Process (+)

TABLE 2

POLARITY OF DESCRIPTIVE ADJECTIVES FOR INSTRUMENT CONCEPTS CONSIDERED TO BE POSITIVE*

(-)	competitive	cooperative	(+)
(+)	simple	complex	(-)
(-)	unsuccessful	successful	(+)
(+)	valuable	worthless	(-)
(+)	clear	hazy	(-)
(+)	permissive	restrictive	(-)
(-)	stale	fresh	(+)
(+)	fair	unfair	(-)
(-)	static	dynamic	(+)
(+)	good	bad	(-)
(-)	rigid	flexible	(+)
(+)	enjoyable	unenjoyable	(-)
(+)	true	false	(-)
(-)	negative	positive	(+)
(-)	boring	interesting	(+)

* For instrument concepts considered to be negative, e.g. facts, the polarity of the descriptive adjectives is reversed.

TABLE 3

INSTRUMENT CONCEPTS FOR WHICH SIGNIFICANT CHANGES WERE MEASURED

(N=29)

CONCEPT	PRE-TEST MEAN	POSTTEST MEAN	STANDARD ERROR OF THE DIFFERENCE BETWEEN CORRELATED MEANS	T-VALUE*	LEVEL OF SIGNIFICANCE
Discovery	81.8	86.3	1.73	2.62	.05
Independent Study	82.0	85.3	1.31	2.52	.05
Inquiry	80.1	84.2	1.60	2.57	.05
Model Building	79.1	86.6	2.22	3.38	.01
Laboratory Investigations	82.3	86.2	1.72	2.29	.05
Problem Solving	73.8	78.0	1.97	2.16	.05
Science as Content	53.4	46.2	2.34	(3.07)	.01
Science as a Way of Thinking	81.8	86.1	1.76	2.46	.05
Science as Process	77.7	83.7	2.72	2.23	.05
Total Instrument Score	1780.0	1840.0	12.91	4.60	.01

* Computer program used to calculate correlated t-values

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